DIAGNOSTIC SIGNIFICANCE OF THE FIRST SOUNDS OF THE HEART.

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Circular 21, S. G. O.,[1] issued especially to the cardiovascular examiners is a definite statement of the most advanced standpoint in the diagnosis of heart conditions, and as such deserves to be called to the attention of all clinicians.

One of the most striking features of Circular 21 is the absolute disregard of the systolic murmur, the interpretation of which is usually considered the ultimate test of our diagnostic ability. Lewis[2] had previously called attention to the lack of agreement among physicians as to the meaning of the various types of apical systolic murmurs. But neither Lewis, nor Janeway in Circular 21, offered a substitute standard for cardiac examinations.

Such a standard, I think, may be found by comparing the first sound over the right and left ventricles. Dana's[3] recent confirmation of this idea leads me to believe that a statement as to the possibilities of this method would not be without interest.

The cause of the first sound of the heart seems to be an accepted physiological fact. At least the description varies little in the textbooks, and all agree in stating two factors, muscle contraction and auriculoventricular valve tension. As one studies the effects of mitral valve lesion on the first sound, one is led to doubt the usual explanation, at least, as applied to muscle contraction. If, however, one can consider the first sound as due to tension in muscle as well as in valve the changes in the first sound as a result of valve and muscle disease can be easily understood.

The theory of Martius, supported by Howell, that the first sound begins during the time of total closure of the ventricle, that is, when there is no movement of the blood within the chamber, seems to substantiate the idea that almost the entire first sound is a result of tension of both valve and muscle. It is true that the first sound lasts longer than the time of total closure, but it is also true that when there can be no total closure, that is, with mitral regurgitation, the first sound, making all allowance for the peculiarities of conduction, is absent. The laws of conduction of sound within the chest are but slightly understood, and for this reason the interpretation of sound heard must always be based upon changes in conduction as well as in character.

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[1] Circular 21, Surgeon-General's Office, July, 1917.

[2] Medical Research Committee, Special Report No. 8, London, 1917.

[3] Heart Muscle Equation, Am. Jour. Med. Sc., June, 1919.

The evidence obtained by percussion in the examination of the heart is valuable in many instances, but in the very case where most needed a rigid thorax, an emphysema or some one of the other sources of error makes the result of percussion uncertain. When one has seen a clear-cut stereoscopic radiograph of the heart and mediastinum one is not inclined to rely very much upon the percussion outline.

So with systolic murmurs under suspicion as diagnostic criteria, and percussion outline unreliable, any procedure which will give definite information is to be utilized to the utmost. And such a source of information is to be found in the study of the first sounds of the heart.

Exactly the same series of events occur synchronously in the right and left heart, with the result that the normal heart sounds thus produced are fused into a single first sound; but just as we have been taught to differentiate systolic murmur by the point of maximum intensity and the direction of transmission, so we can learn to tell the first sound as created in the right heart from that in the left by studying these sounds at the point of optimum clearness. The sounds then can be compared by auscultation, first, over the right ventricle and then over the left. In the fourth or fifth interspace, just to the left of the sternum, the right first sound is heard most clearly, but considerable liberty of selection is allowed in order to find the place where there is the least possible interference from conduction. The first sound originating in the left ventricle is best heard just above and within the apex-beat, the classic area of mitral stenosis murmurs. How much depends upon the proper selection of these areas to avoid confusion can best be realized when one remembers the definite localization of the very loud presystolic murmur and snappy first sound of mitral stenosis.

In a normal heart the first sound right and left are practically the same in length and quality of tone, but the right not quite so loud.

The first sound over the right ventricle is almost always normal or standard, because disease of the tricuspid valve is rare, and such hypertrophy as occurs here is in total amount so slight that changes in sound due to this are beyond our interpretation.

Considering, then, the right first sound as the individual standard; comparing this with the left first sound as heard at the apex, we find that the left first sound may be increased, diminished, absent or show complete changes in character.

The increased first sound left is perhaps best typified by the booming first sound of aortic insufficiency. This seems to be due to increased muscle tension and varies directly with the amount of hypertrophy of the left ventricle and with the condition of the heart muscle. The first sound in infectious aortic insufficiency is louder and longer than in degenerative aortitis, in which there are usually heart muscle changes as well. Hypertrophy of the left ventricle from any cause produces similar changes in tone quality of the first sound left, but when the hypertrophy is bilateral the tone quality of the right first sound is also affected, and then differentiation is more difficult.

According to Martius the first sound left must be absent in mitral insufficiency because this lesion makes it impossible for the left ventricle to have a "time of total closure."

In a very large proportion of the cases of pure mitral insufficiency we do not hear a first sound left, and it is perfectly safe to make a diagnosis of organic regurgitation, upon this combination of no first sound at the apex and a loud systolic murmur, with normal first sound right. Likewise, it is impossible to substantiate a diagnosis of mitral insufficiency when there is systolic murmur and a normal first sound left. Difficulty arises when a changed first sound left and murmur is heard, and in such instances a very careful examination is necessary to determine whether the first sound heard at the apex is conducted from the right side or whether, in truth, the first sound originates within the left ventricle. If the first sound has the same quality and tone as a normal first sound left, but is merely shorter in duration and followed by a murmur, the exercise test will many times cause the sound to disappear and be replaced, in its entirety, by a systolic murmur. Under these circumstances we have no hesitancy in diagnosing myocardial degeneration with relative mitral insufficiency. Even without the systolic murmur, shortening of the first sound left, with changes which seem to be due to lack of muscle tone, can frequently be changed by exercise into a definite systolic murmur without first sound; and here, again, we are justified in making a diagnosis of myocarditis with relative mitral insufficiency.

When the first sound as heard at the apex is shorter than the normal first sound on the right side, and of slightly different tone quality, the change not due to conduction and persisting through the exercise test, one must either dismiss entirely the diagnosis of mitral insufficiency or add thereto the diagnosis of mitral stenosis. The correct diagnosis can be made by a careful study of diastole in various postures and with different amounts of exercise, keeping well in mind the typical exercise response of mitral stenosis, which consist in suddenly developing dyspnea and peripheral cyanosis. Even when no murmurs can be heard in diastole this first sound may be an approach toward the snappy first sound of mitral stenosis, and must be considered as indicating possibly an early phase of mitral disease of the progressive type, which will ultimately develop a predominating stenosis.

The buttonhole mitral stenosis gives the most typical snappy first sound, which may be likened to the sound of a single stroke on the tambourine. For the purpose of comparison it may be said that the valve element dominates this sound exactly as the muscle element dominates in booming first sound. Mitral stenosis can scarcely be diagnosed without the snappy first sound, but this, in addition to practically any form of diastolic murmur, save that of aortic insufficiency, means mitral stenosis.

In those cases of mitral stenosis presenting 3–4 rhythm, it must be remembered that the second of the sounds is the true first sound and is the one which has the characteristic tambourine quality.

When one has learned the difference in tone quality of the right and left first sound in a typical case of buttonhole mitral stenosis it is then much easier to pick out the changes described in the preceding paragraphs. It must be remembered that in double mitral lesions we cannot determine by auscultation which defect dominates in disturbing the physiology of the circulation. This important differentiation depends entirely on the size of the left ventricle, as shown by the position of the apex-beat and the percussion outline.

If we rely upon this classic combination of presystolic thrill, presystolic roll and snappy first sound, we will be able to diagnose only 30 to 40 per cent. of the cases of mitral stenosis. Any change in first sound left should direct our attention to a more careful survey of diastole, and we will then be able to recognize the early and atypical cases of mitral stenosis.

The first sound in Graves's disease is shortened both right and left and has a rather peculiar stroke, which allows one to differentiate it clearly from an equally rapid systole, due to other conditions. Usually in these rapid pulse cases the first sound right and left are similar, but in certain cases of neuro-circulatory-asthenia the right first sound remains normal while the left first sound takes on the quality of thyroid heart. It is interesting to note, however, that in those neuro-circulatory-asthenia cases which respond unfavorably to exercise from very slight exertion the right first sound also becomes quicker and shorter and approximates the left first sound.

In approaching death from infectious disease and also in so-called surgical shock cases there is a gradually increasing loss of tone in the first sound, both right and left, until twenty-four to thirty-six hours before death, we have the tick-tack heart in which the first and second sounds are alike, and from six to twelve hours before death one sound is lost, and upon the most careful auscultation only the single sound can be heard.

Incidentally, I may remark that after the stage of the tick-tack sound is reached I have never seen any form of stimulation bring about a reaction on the part of the heart muscle, although up to this stage, stimulation, preferably with the caffein group, frequently brings about marked improvement.

Reduplication of the first sound is by no means infrequent, but as long as the reduplication occurs without disturbing the 2–4 rhythm of the heart no importance is to be attached to this. On the contrary, when the extra sound changes the rhythm from 2–4 to 3–4 gallop rhythm it is always of the utmost significance. When we study this rhythm by comparison of the first sound right and first sound left, we find it almost always limited to the left ventricle, occasionally to the right, but exceptionally it may occur over both.

The synonym rhythmus brightique is given to this condition because it most frequently occurs in the left ventricle hypertrophied as a result of arteriosclerotic kidney, but it can occur in any form of hypertrophied heart muscle. The occurrence of the 3–4 rhythm localized over the right ventricle is not uncommon in kyphosis and other extreme deformities of the chest. This 3–4 rhythm always means degenerative hypertrophic heart muscle, which is on the verge of "failure" in Mackenzie's interpretation of this word.

Furthermore, demonstration of the 3–4 rhythm is a positive indication for the administration of digitalis which will usually restore the normal rhythm. If not treated with digitalis the case very soon progresses to the usual manifestations of conclusive decompensation. Since a very much larger percentage of cardiovascular-renal cases finally break under heart symptoms than is generally believed, eliciting this 3–4 rhythm as an early sign of approaching heart muscle weakness, is of great value.

Behavior of the first sound in the various forms of cardiac irregularity presents many interesting features. For instance, in mitral insufficiency of the type described above the long systolic murmur and no first sound, with ectopic beats, the first sound is heard over the apex with the premature contraction, and usually seems louder, the earlier and more incomplete the ectopic beat. This also holds true in cases of tricuspid insufficiency where the same condition can be demonstrated over the right ventricle.

In mitral stenosis with fibrillation the snappy first sound is heard only with those systoles which present a normal pulse wave, and inasmuch as fibrillation of the auricle does away with practically all diastolic murmurs a diagnosis of mitral stenosis again depends upon comparison of the first sound right and left.

I am quite aware that I have presented nothing new, and nothing that is not to be found, better described, in the text-books on physical diagnosis, but the fact remains that the teaching of physical diagnosis has always laid undue importance upon systolic murmurs in the study of the heart, and sounds have been neglected. Each clinician must learn for himself to interpret the phenomena of the heart, and in so doing he places more or less importance upon the sounds; but, unfortunately, he does not formulate this knowledge in such a way that it is available for demonstration, and what I have offered here is merely a suggestion to substitute for an illy defined memory picture of the first sound of the heart the normal standard of the right first sound.